MULTIMEDIA UNIVERSITY

STUDENT ID NO

TABLE NO: _____

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

TCP2101 ALGORITHM DESIGN AND ANALYSIS / TCS3211 ALGORITHM ANALYSIS

(All sections/groups)

14 OCTOBER 2017
2.30 p. m. – 4.30 p. m.
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENTS

1. This question paper consists of thirteen (13) printed pages only including the cover page.
2. There are four (4) questions in this paper.
3. Answer **ALL QUESTIONS**. All questions carry equal marks (25 marks) and the distribution of the marks for each sub-question is given.
3. Please write all your answers **in the spaces provided in this Question paper**.

Question 1

a) Assuming that each of the expressions below have a running time of T(n) and input size of n, specify the lowest Big-Oh complexity for each of them.

[5 marks]

Expression	O(...)
$5 + 0.01n^3 + 0.25n^2$	
$0.1n + 100n^2$	
$n^2\log_2 n + n(\log_2 n)^2$	
$n\log_3 n + n\log_2 n$	
$2\log_5 n + 2\log_2 n$	

b) Using the results from (a), arrange the running times (Big-Oh notations) in ascending growth rate order

[5 marks]

c) The following sequence of 8 numbers are inserted into the hash table below using the hash function `h(k) = k % 8`.

17 10 13 11 27 23 36 38

Calculate and fill in the following table with the hash values for the sequence.

[4 marks]

k	17	10	13	6	5	23	11	20
h(k)								

Continued ...

d) Complete the hash table below with the values you obtained from (c) and use *quadratic probing* to resolve any collisions that arise. Show the individual hashes performed to resolve all the collisions in the space below.

[8 marks]

h(k)	0	1	2	3	4	5	6	7

e) Assume you have 300 items you want to store and index using the hash function **`h(x) = x % tablesize`**, suggest and justify a possible **`tablesize`** such that you can store all the items with minimal collision.

[3 marks]

Continued...

Question 2

a) Given the number sequence below, show the steps to create the initial max-heap if the sequence is treated as a single input array.

6 7 15 10 3 16 20

Draw the tree for each individual step in the space below.

[5 marks]

Continued...

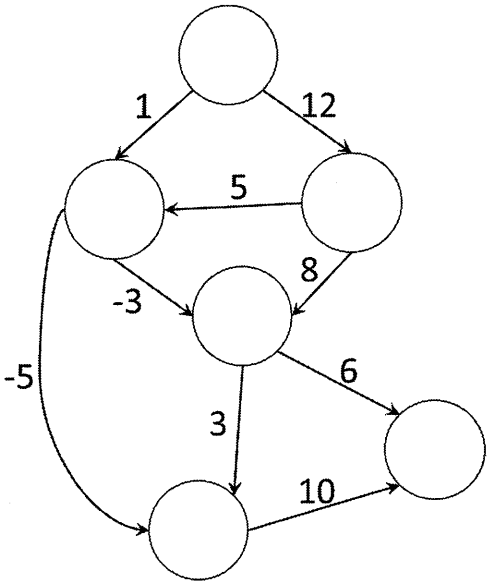
b) Using the resulting tree you obtained from (a), show how the dequeue process works to empty the heap in a *heapsort* operation. Draw the individual steps of the heapsort below.

[6 marks]

Continued...

c) Complete the following digraph by filling in the empty vertices with the numbered sequence of the vertices after they are sorted topologically.

[6 marks]



d) Using the numbered digraph you created from question (c), create the adjacency matrix representation of the graph in the space below.

[6 marks]

e) Graphs can be represented using adjacency matrices or adjacency lists. Which method requires more space when representing a sparse graph? Would this change if they were representing dense graphs instead? Explain your answer.

[2 marks]

Continued...

Question 3

a) Complete the table below with the average-case and worst-case time complexities for the algorithms listed

[4 marks]

Sorting Algorithm	Time complexity, O(...)	
	Average	Worst
Selection		
Radix		
Heap		
Merge		

b) Use Master Theorem to find the Big-Oh time complexity for the following equations. The three cases used in the Master Theorem are shown below:

i. $T(n) = 64T(n/3) - n^3 \log 3n$
ii. $T(n) = 7T(n/3) + n^2$
iii. $T(n) = 3T(n/3) + n/3$

The Master Theorem:

1. if $f(n)$ is $O(n^{\log_b a - \varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Omega(n^{\log_b a + \varepsilon})$, then $T(n)$ is $\Theta(f(n))$
3. if $f(n)$ is $\Theta(n^{\log_b a} \log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a} \log^{k+1} n)$

[9 marks]

Continued...

c) Explain what it means to have a stable sorting algorithm and why is it important?

[3 marks]

d) Illustrate the operation of the radix-sort algorithm on the following list of words (assuming that each cycle sorts in alphabetical order).

COW, DOG, RUG, SEA, ROW, MOB, TEAR, FACE, BOX, TAB, HOUSE

[5 marks]

Continued...

e) Is the radix-sort a stable sorting algorithm? Justify your answer with a simple example of your own.

[4 marks]

Question 4

a) Explain briefly what knapsack problems are and how the fractional knapsack and 0/1 knapsack approaches differ from each other.

[4 marks]

Continued...

b) Betty is a shopaholic and wants to take advantage of the sales at shopping malls. Depending on the malls she visits, there are different numbers of shops that interest her and she can purchase items from. To limit her spending on travelling, she decides that she only visits one mall per day and her fuel budget only allows her to go for a maximum of 75km. The following table shows the malls, the total travelling distance and the number of shops per mall.

Mall name	A	B	C	D	E	F
Distance (km)	15	6	21	30	28	28
Shops	7	3	5	1	4	8

What is the list of malls to visit and the maximum shops Betty can visit if fuel is her main limitation and she does not revisit the same mall? Propose a feasible method to solve her problem and justify the reasons for your answer

[8 marks]

Continued ...

c) Show the steps taken if the Boyer-Moore algorithm is used to find the word 'FOOTBALL' in the phrase below

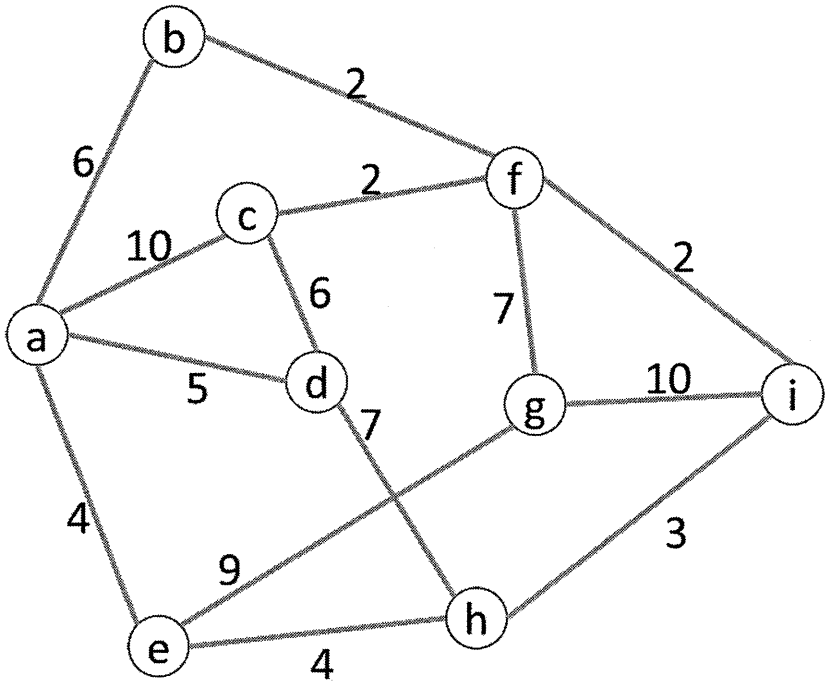
```
OFTEN AT TIMES, FOOTBALL IS CONFUSED WITH OTHER SPORTS...
```

[4 marks]

Continued ...

d) Using the weighted undirected graph below, show how Dijkstra's algorithm works to find the shortest paths from vertex 'a' to all the other vertices.

[9 marks]



Continued...

End of paper